PEER REVIEW HISTORY

ARTICLE DETAILS

TITLE (PROVISIONAL)	Association Between Daily Life Walking Speed and Frailty Measured by a Smartphone Application: A Cross-Sectional Study
AUTHORS	Kawai, Hisashi; Obuchi, Shuichi; Ejiri, Manami; Ito, Kumiko

VERSION 1 – REVIEW

REVIEWER	Kurita, Satoshi National Center for Geriatrics and Gerontology
REVIEW RETURNED	10-Aug-2022

GENERAL COMMENTS	Because lower walking speed is one of the components of frailty assessment in the Japanese version of the CHS criteria, I could not understand why the authors try to identify frailty by only daily walking speed. In addition, because frailty is a health problem for mainly older adults, the authors should explain why participants have included not only older adults aged over 65 but also middle-aged adults.

REVIEWER	Perracini, Monica Universidade Cidade de Sao Paulo, Physical Therapy
REVIEW RETURNED	26-Sep-2022

GENERAL COMMENTS	The study topic has been relevant and ubiquitous since the pandemic, and globally there has been an increase in the use of digital technologies to help with the health care of older adults, mainly related to daily life monitoring. The rationale is reasonably established, considering the applicability of using a smartphone with a GPS to measure walking speed and its capacity to identify frail older people. However, two main points are important and deserve more information in the article as a whole: 1. For monitoring and preventive purposes, it would be clinically relevant to identify older people who are pre-frail and frail; why does the study focus only on frail older people in comparison with robust older people? 2. Daily walking speed as a surrogate of overall mobility can vary depending on the built environment as an ecological rather than a laboratory measure. Walking can be complex depending on external inputs such as obstacles, noise, sidewalks conditions, etc. An ecological approach/framework would strengthen the article. The discussion section is lengthy and does not target to discuss the main study result, which is a possible difference in the step length between the two groups, considering that the observed difference was true. Anyway, the AUC was frustrating, and it

	should be interpreted cautiously. The main point here is not identifying cutoff points. I would recommend a revision of the discussion section. The conclusion in the abstract is misleading. Please revise. Page 4, Line 15 – 17: I would say that it is not conventional walking speed, but rather usual or habitual walking speed measured conventionally. The distance varies a lot, and it is not needed here. Page 4 Line 38 – Please specify key differences in DWS definitions and the one used in the study. Page 4 Line 40 – Please specify values of DWS, for instance, average speed and minimal detectable change. Page 5, Line 43 – It would be essential to describe a little bit more if there are environmental differences between the locations/prefectures where the study was conducted, since DWS is an ecological measure. Page 6, Line 10 – Please clarify if there were any exclusion criteria, such as cognitive decline or visual limitation. Moreover, specify if participants received help from other people to download the app or fill in the chatbot questions. Page 6 Lines 23 – 41 – Overall, some critical information is missing regarding how the GPS was tracked. For example, environments with decreased visibility are crucial for a real-world evaluation of walking, the system's accuracy, and how researchers overcome this barrier. In addition, a more detailed comment would be helpful on what they considered a stable walking trajectory. Page 6, Line 48 – Please provide the values for test-retest reliability for DWS, gait speed, and the other gait parameters: step length and cadence. The measurement error for step length must be provided since we can see if the difference between robust and frail is true rather than a measurement error. Page 7 – Please provide further information about the KCL instrument, such as its feasibility for identifying pre-frailty and psychometric measures for validation. Page 7 – Participants' Characteristics – Please comment on other possible co-variables that might interfere with DWS, such as visual problems, fear of falling, and use of assistive walking devices, such as canes and walkers. Page 12 – Please revise the discussion to include the limitations at the end of the section. For example, Lines 10 – 17 are a study limitation, and it did not help with the key discussion, and it is contradictory if what is written in lines 42 and 43. Page 13 Line 44 – Please provide a reference for 0.07 m/s. In an article, 0.12 m/s for not high-quality tracts are also considered. So, it could detect differences in the present study with the included sample size.

VERSION 1 – AUTHOR RESPONSE

Reviewer: 1

Because lower walking speed is one of the components of frailty assessment in the Japanese version of the CHS criteria, I could not understand why the authors try to identify frailty by only daily walking speed. In addition, because frailty is a health problem for mainly older adults, the authors should explain why participants have included not only older adults aged over 65 but also middle-aged adults.

Response: We thank the reviewer for your comments. Results from the ROC analysis were removed because the aim of this study was to examine whether DWS was associated with frailty.

As the reviewer pointed out, frailty is a problem that mainly affects older adults, however, we invited people aged 55 and over in order to recruit more participants. Although participants under 60 years were included in the analysis, there were only two participants aged 57 and 59 among these. Therefore, almost all participants were older individuals. This was added to Discussion section. (Page 13)

Reviewer: 2

The study topic has been relevant and ubiquitous since the pandemic, and globally there has been an increase in the use of digital technologies to help with the health care of older adults, mainly related to daily life monitoring.

The rationale is reasonably established, considering the applicability of using a smartphone with a GPS to measure walking speed and its capacity to identify frail older people. However, two main points are important and deserve more information in the article as a whole:

1. For monitoring and preventive purposes, it would be clinically relevant to identify older people who are pre-frail and frail; why does the study focus only on frail older people in comparison with robust older people?

Response: We thank the reviewer for this comment. We focused on frailty in order to examine its association with DWS, which has not been examined in the previous studies. As the reviewer pointed out, the association with pre-frailty is also important. We therefore decided to show pre-frailty results in our univariate analysis. We did, however, only retain frailty-related data in the multivariate analysis due to the lack of statistical power.

2. Daily walking speed as a surrogate of overall mobility can vary depending on the built environment as an ecological rather than a laboratory measure. Walking can be complex depending on external inputs such as obstacles, noise, sidewalks conditions, etc. An ecological approach/framework would strengthen the article.

Response: We thank the reviewer for this comment. Although walking speed in daily life can change depending on environment and circumstances, in our previous study,[11] we showed that walking speed measured using this application multiple times in daily life has a single-peaked normal distribution. This was added to the “Measurement of Daily Walking Parameters” section. (Page 7)

The discussion section is lengthy and does not target to discuss the main study result, which is a possible difference in the step length between the two groups, considering that the observed difference was true. Anyway, the AUC was frustrating, and it should be interpreted cautiously. The main point here is not identifying cutoff points.

I would recommend a revision of the discussion section.

Response: We thank the reviewer for this suggestion. Since calculating the predictive ability and cutoff points was not the real aim of this study, the ROC analysis was removed from all sections.

The conclusion in the abstract is misleading. Please revise.

Response: We thank the reviewer for this comment. We revised the relevant sentence to “DWS measured using the smartphone application was associated with frailty. This was probably due to the shorter step length and body height seen in frail individuals.” (Page 2)

Page 4, Line 15 – 17: I would say that it is not conventional walking speed, but rather usual or habitual walking speed measured conventionally. The distance varies a lot, and it is not needed here.

Response: We thank the reviewer for this comment. We revised the relevant sentence to the following: “Usual walking speed has been often measured by recording the time required to walk a certain distance using a stopwatch in the previous studies.” (Page 4)

Page 4 Line 38 – Please specify key differences in DWS definitions and the one used in the study.

Response: We thank the reviewer for this comment. We added text as follows: “However, the measurement of DWS is not well-established, and its definition differs depending on the study, with variations in factors such as differences in sensor type used for measurement (accelerometer vs GPS), range of days for measurement (14 days vs 1 week), and representative value (average vs percentile).” (Page 4)

Page 4 Line 40 – Please specify values of DWS, for instance, average speed and minimal detectable change.

Response: We thank the reviewer for this comment. We specified the values as follows: “previous studies on DWS have only shown the relationship between average[6,10] or percentile values of DWS[8,9] and LWS, minimal detectable change in 95% (MDC95) of average of DWS[7], and age-sex reference values for average DWS,[11]” (Page 4)

Page 5, Line 43 – It would be essential to describe a little bit more if there are environmental differences between the locations/prefectures where the study was conducted, since DWS is an ecological measure.

Response: We thank the reviewer for this comment. We added the following sentence to the manuscript: “These are neighbouring prefectures, and the environmental characteristics of the regions are similar.” (Page 5)

Page 6, Line 10 – Please clarify if there were any exclusion criteria, such as cognitive decline or visual limitation. Moreover, specify if participants received help from other people to download the app or fill in the chatbot questions.

Response: We thank the reviewer for this comment. We added the following sentence to manuscript accordingly: “Individuals were included in this study if they habitually used a smartphone, could walk independently, and were not recommended restricted physical exercises by a doctor. We did not examine whether participants received help downloading or operating the application.” (Page 6)

Page 6 Lines 23 – 41 – Overall, some critical information is missing regarding how the GPS was tracked. For example, environments with decreased visibility are crucial for a real-world evaluation of walking, the system's accuracy, and how researchers overcome this barrier. In addition, a more detailed comment would be helpful on what they considered a stable walking trajectory.

Response: We thank the reviewer for this comment. We added the following explanation to clarify how the GPS was tracked to the “Measurement of Daily Walking Parameters” section:

“A stable walking trajectory was detected from position information acquired by the smartphone GPS during walking using the linear least squares method (patent number: WO2016043081).[7]” (Page 6)

We added the following sentence regarding how researchers overcome this barrier:

“GPS measurements may be difficult to obtain because of buildings and terrain types, including outdoors. However, this problem was overcome using all positions measured by the GPS during walking and using the average value of walking speed measured multiple times a day, rather than using only the beginning and ending positions.” (Page 7)

Page 6, Line 48 – Please provide the values for test-retest reliability for DWS, gait speed, and the other gait parameters: step length and cadence. The measurement error for step length must be provided since we can see if the difference between robust and frail is true rather than a measurement error.

Response: We thank the reviewer for this comment. We added text as follows: “The MDC95 for DWS, DW step length, and DW cadence in our previous study[7] was 0.101 m/s, 5.662 step/min, and 3.498 cm, respectively.” (Page 7)

Page 7 – Please provide further information about the KCL instrument, such as its feasibility for identifying pre-frailty and psychometric measures for validation.

Response: We thank the reviewer for this comment. We added text as follows: “The KCL is a simple yes/no questionnaire that assesses multiple aspects of physical, oral, cognitive, and psychosocial functions. Total KCL score was significantly associated with pre-frailty and frailty based on the CHS criteria in the previous study. Further, this study showed that pre-frailty and frailty by KCL can predict the incidence of 3-year dependency and mortality in older adults.[16]” (Pages 6-7)

Page 7 – Participants' Characteristics – Please comment on other possible co-variables that might interfere with DWS, such as visual problems, fear of falling, and use of assistive walking devices, such as canes and walkers.

Response: We thank the reviewer for this pertinent comment. We did not examine those covariables. In response to this comment, we added the following sentence to the limitations section: “We also did not examine other possible covariates that may affect DWS, such as visual impairment, fear of falling, and walking aids.” (Page 16)

Page 12 – Please revise the discussion to include the limitations at the end of the section. For example, Lines 10 – 17 are a study limitation, and it did not help with the key discussion, and it is contradictory if what is written in lines 42 and 43.

Response: We thank the reviewer for this pertinent suggestion. Lines 10-17 have been moved to the limitations section and lines 42-43 were have been removed accordingly.

Page 13 Line 44 – Please provide a reference for 0.07 m/s. In an article, 0.12 m/s for not high-quality tracts are also considered. So, it could detect differences in the present study with the included sample size.

Response: We thank the reviewer for this comment. We revised to the relevant sentence to “the difference in DWS between the robust and frailty groups was 0.08 m/s, which was smaller than 0.101 m/s for MDC95 of DWS.[7] Therefore, the statistical power in this study may be slightly insufficient to detect this difference.” (Page 15)

VERSION 2 – REVIEW

REVIEWER	Perracini, Monica Universidade Cidade de Sao Paulo, Physical Therapy
REVIEW RETURNED	07-Nov-2022

GENERAL COMMENTS	The authors addressed all the questions raised in the first round, improving the paper. Particularly, I think the GPS as a way of identifying mobility limitations is promising, but it still needs to be analyzed using larger samples. I hope you can expand your research in the future.