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A journey of a thousand miles: from "Manpo-Kei" to the first steps-based physical activity recommendations

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Keywords:	Physical activity, Walking, Cohort Studies, Epidemiology

Review : Response to Reviewers' Comments (bjsports-2023-106869*)*

Title: "A journey of a thousand miles: from "Manpo-Kei" to the first steps-based physical activity recommendations"

	Comment	Author Response & Changes made
EDITORIAL COMMENT (FORMATTING)	Please make sure the following statements are included in the main document file, which should match the details given in the submission pages: 1. Competing interests 2. Contributorship, in detailed form 3. Acknowledgements 4. Funding, grant/award info, name and numbers If there is no information to add, please include: none or not applicable. 5. Supplementary material will only be published on an 'as supplied' basis, without checking for accuracy or proofing and preferably submitted in PDF format.	We have addressed all these formatting comments.
EDITORIAL COMMENT (PEER REVIEW)	we have received the referee reports for your editorial. All three reviewers are positive. Minor revisions are required before the editorial can be accepted for publication.	
REVIEWER 1 (#)		**Response**
1.1	This is a clear, authoritative and objective assessment of the current state of steps-based recommendations. It includes both sides of any debate including challenges to be addressed. It will be a strong addition to the literature	We thank the reviewer for their positive remarks.
REVIEWER 2 (#)	**Comment** <u>Introductory comment</u> Thank you very much for the opportunity for reviewing this manuscript. This editorial aims to discuss the opportunities and	We thank the reviewer for their positive remarks.

	challenges surrounding the addition of stepping-based recommendations to future physical activity guidelines. I read it with great interest. I have some suggestions and comments to further improve the manuscript.	
2.1	It would be helpful to provide more information as to why steps may be more concrete than time at a particular intensity, as a behavioral metric .	We added the following text: *"For some people, steps may be an easier to monitor and more concrete behavioural metric than time at a particular intensity. For example, step counting devices (pedometers, accelerometers, or smartphones), have historically been more accessible than MVPA-quantifying devices."*
2.2	Supplementary image 1, are there no copyright issues with this image? I think the authors need to ask Yamasa company for permission to use it. https://protect-au.mimecast.com/s/j85ZCQnMBZfX681XMFxtAnt?domain=yamasa-tokei.co.jp	As we were not able to contact Yamasa for copyright clearance, we removed Suppl Image 1 and provided a citation with the URL the reviewer provided.
2.3	Although this is an editorial (and the reference is limited), I would recommend adding references that indicate socioeconomic inequalities in fitness tracker and smartwatch ownership rates. The differences in their ownership rates may represent disparities in physical activity (those who are more physically active own more devices) rather than socioeconomic inequalities.	We added one reference that indicated socioeconomic patterning of wearable technologies: Honeyman M, Maguire D, Evans H, et al. Digital technology and health inequalities: a scoping review. EuroHealthNet 2020.
2.4	'Evidence translation' seems a bit short and not enough. It would be helpful to strengthen this part. For example, previous studies on step count and MVPA guideline transitions has already been done. (e.g., PMID: 18562971, 23438219, and 21295063). What do the authors think about this point?	We would be very keen to expand and add these important references which refer to previous physical activity guidelines. However, we have added several additional references to address other reviewer comments, plus the 'Evidence translation' section occupies >200 words, i.e. >25% of the whole manuscript. We are constrained by a word limit of 800, which we already exceed. We would also like to note comment R3.4 by reviewer 3 who highlighted that "*Evidence translation : Excellent section, really covering nuances between the two*

		approaches, that will, invariably, be an on going challenge for practitioners and policy makers alike."
REVIEWER 3 (#)	**Comment :** This editorial is very nicely crafted, and definitely sets the scene for an emerging uptake of step based guidelines by policy makers. The editorial covers background, challenges, and future plans well.	**Response:** We thank the reviewer for their positive remarks.
3.1	Daily steps: an old-new target? : A really very nice preamble to the rest of the editorial. Both accurate and poetic in its craft.	Thank you
3.2	Opportunities : Provide some citation to back up these figures. I think this is important, so the veracity of the statements can be verified. Indeed, particularly important given the tone and climate of the editorial. As you rightly point out, such ownership is entwined with inequity; nevertheless, the costs associated with such devices has sharply fallen in recent years – to that end, a date marker for the figures mentioned would be sensible. Given the rapidly changing landscape.	We have added the 2 citations where these figures were sourced from. Also, see our response to comment R2.3 above detailing a reference we added to back up the socioeconomic gradient of wearables ownership
3.3	Challenges, evidence synthesis : you write "It is not clear how validity varies across accelerometer placements (e.g. wrist1 2 5 vs hip6 7 vs thigh8). Every step counting method defines a "step" differently (e.g. how static shuffling counts1 2 6). It is not clear how calculations of minimal and optimal daily steps are affected by the use of different reference groups across studies, e.g. 12482 vs 15441 vs 20006 steps/day" >> These short sentences read as quite jarring, without feeling connected. I feel that they need to be combined in some way, with the point of the statements being made clearer.	We thank the reviewer for this comment. We addressed the reviewers' helpful comment by thoroughly restructuring and revising this paragraph to improve its flow, and by creating a list of the "jarring" sentences. The revised paragraph reads as follows: *"Evidence synthesis* *Critically, guideline developers should acknowledge that the questionnaires used to derive current time-based MVPA targets[4] and step-counting devices capture different constructs: questionnaires capture continuous blocks of time when bouts of MVPA (including stepping) occur, whereas devices capture stepping of any duration and intensity. On its own, ~~plain~~ number of steps is an intensity-agnostic metric which does not reflect short and intermittent (up to 1-2 minutes) vigorous intensity bouts[9] which may be*

		*associated with health benefits over and above stepping volume.[1 2] Some recent 24-hr accelerometry studies using wrist or thigh-worn devices [1 2 10 11] suggested that optimal mortality and chronic disease risk factors reduction occur at around the popular 10,000 steps per day target. In its entirety, however, literature on minimal and optimal numbers of steps is far from conclusive as there are major differences in the calculation and reporting methods across studies[1 2 10 11 12 13]." (**Figure 1**). Numerous other methodological issues merit attention during evidence synthesis, including a) the lack of clarity on how validity varies across accelerometer placements (e.g. wrist[1 2 11] vs hip[12 13] vs thigh[10]); b) the differential definition of a "step" across counting method (e.g. how static shuffling counts[1 2 13]); c) how calculations of minimal and optimal daily steps are affected by the use of different reference groups across studies, e.g. 1248[2] vs 1544[1] vs 2000[13] steps/day; d) how real-time behavioural feedback affects estimates from consumer-level devices that may be worn for years[11]; e) how the output of such devices compares with research grade devices worn for a week or less [1 2 10 12 13]."*
3.4	Evidence translation : Excellent section, really covering nuances between the two approaches, that will, invariably, be an on going challenge for practitioners and policy makers alike.	Thank you
3.5	Overall, terrific job encapsulating the current state of play. I think my very minor suggestions would make some small semblance of an improvement, and i hope the authors think so to. I look forward to seeing this published, and engaging in	Thank you again.

Title: A journey of a thousand miles: from "Manpo-Kei" to the first steps-based physical activity recommendations

Authors: Emmanuel Stamatakis[1 2], Matthew N. Ahmadi[1 2], Marie H Murphy[3], Timothy JA Chico[4], Karen Milton[5], Borja del Pozo Cruz [6 7 8], Peter T. Katzmarzyk[9], I-Min Lee [10 11], Jason M.R. Gill[12]

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- Manuscript main text: 867 words
- 13 references

Display Items

1 Figure; 1 Supplemental item

Keywords: wearables, physical activity, stepping, walking, cohort studies, accelerometry, guidelines, epidemiology

TEXT

Stepping – encompassing walking, running, and stair-climbing – is the fundamental mode of human movement. Higher stepping volume and intensity is associated with favourable health outcomes.[1 2] Over the last quarter of the century, stepping has declined by over 1000 steps per day (7-13% of total count[3]), roughly equivalent to ~10 minutes of brisk walking. As a simple 'objective' measure of ambulatory physical activity, formal stepping-based recommendations may provide a target that is easy to understand and monitor. As self-monitoring of steps may be an effective physical activity intervention, such recommendations may support more people to be sufficiently active. This editorial discusses the opportunities and challenges surrounding the addition of stepping-based recommendations to future guidelines.

Daily steps: an old-new target?

Current physical activity recommendations are based on weekly duration (time) of moderate and vigorous activity (MVPA)[4]. For some people steps may be an easier to monitor and more concrete behavioural metric than time at a particular intensity. For example, step counting devices (pedometers, accelerometers, or smartphones), have historically been more accessible than MVPA-quantifying devices. Simple mechanical pedometers first appeared almost 60 years ago around the Tokyo 1964 Olympics, with the Yamasa company-designed "Manpo Kei" ("10,000 steps meter") being the first commercial step-counter [5]. The proliferation of step-counting devices in the last 20 years saw the 10,000 daily steps target being treated as an unofficial goal that increasingly attracted public attention (**Supplementary Image 1**).

Opportunities

As cohort studies mature, it is likely that more stepping dose-response studies will be available to inform future guidelines. Consumer trends present another public health opportunity: it has never been easier to track steps and set goals through ubiquitous technology. For example, 93%[6] of people in the UK own smartphones capable of counting steps. Ownership of fitness trackers and smartwatches is also substantial (18% and 17%)[7], although there are clear socioeconomic inequalities in ownership[8] that may compromise population health gains through self-monitoring steps.

Challenges

Evidence synthesis

Critically, guideline developers should acknowledge that the questionnaires used to derive current time-based MVPA targets[4] and step-counting devices capture different constructs: questionnaires capture continuous blocks of time when bouts of MVPA (including stepping) occur, whereas devices capture stepping of any duration and intensity. On its own, number of steps is an intensity-agnostic metric which does not reflect short and intermittent (up to 1-2 minutes) vigorous intensity bouts[9] which may be associated with health benefits over and above stepping volume.[1 2] Some recent 24-hr accelerometry studies using wrist or thigh-worn devices [1 2 10 11] suggested that optimal mortality and chronic disease risk factors reduction occur at around the popular 10,000 steps per day target. In its entirety, however, literature on minimal and optimal numbers of steps is far from conclusive as there are major differences in the calculation and reporting methods across studies[1 2 10 11 12 13] (**Figure 1**). Numerous other methodological issues merit attention during evidence synthesis, including a) the lack of clarity on how validity varies across accelerometer placements (e.g. wrist[1 2 11] vs hip[12 13] vs thigh[10]); b) the differential definition of a "step" across counting method (e.g. how static shuffling counts[1 2 13]); c) how calculations of minimal and optimal daily steps are affected by the use of different reference groups across studies, e.g. 1248[2] vs 1544[1] vs 2000[13] steps/day; d) how real-time behavioural feedback affects estimates from consumer-level devices that may be worn for years[11]; e) how the output of such devices compares with research grade devices worn for a week or less [1 2 10 12 13].

Evidence translation

Contrary to the current time-based recommendations that are harmonised across adult population groups,[4] some stepping literature indicates age differences in dose-response associations[12], making identification of a single stepping target uncertain. The likelihood that time-based and steps-based recommendations will co-exist side-by-side creates a need for messaging consistency so that both targets represent similar amounts of physical activity. Assuming a constant cadence of 110 steps per minute on level ground, a direct interpretation of the currently recommended 150-300 moderate intensity physical activity minutes per week[4] would give approximately 2350-4700 *MVPA steps* per day. The minimum beneficial stepping doses identified in recent studies[1 13] are aligned in terms of the absolute range but do not specify stepping intensity[1 2 13]. Considering that even physically inactive adults record around 2000-4000 light intensity steps during essential incidental activities[2] it is unclear what is the equivalence of the two sets of minimal doses. Similarly, recent literature reporting specifically optimal daily steps (point of lowest risk) [1 2 10 11] includes all steps, not just those performed at moderate to vigorous intensity. With some recent evidence suggesting that metrics reflecting higher stepping intensity may be independently associated with further risk reduction,[1 2] guideline developers may consider specific stepping intensity recommendations.

Conclusions

As the only health behaviour that is passively tracked by nearly ubiquitous technology (smartphones), stepping has a privileged position. Stepping dose-response research has progressed in recent years, providing new insights to inform future physical activity guidelines. The challenges outlined above are *not* insurmountable, previous guideline developers faced unquestionably harder obstacles while developing the current time-based MVPA recommendations using modestly valid self-reports of leisure-time physical activity. The coexistence of steps and time-based recommendations in any future guidelines requires caution to ensure that the former are complementary rather than antagonistic to the latter targets.

Competing interests: None

Contributorship: ES and JMRG conceived the idea, ES drafted the material, all co-authors reviewed the manuscript critically and redrafted parts. **Funding:** ES is funded by the National Health and Medical Research Council (Australia) through an Investigator Grant (APP1194510). BdPC is funded the Government of Andalusia (Spain), Research Talent Recruitment Program (BdPC, EMERGIA 2020/00158)

FIGURE LEGEND

Figure 1: Indicative multivariable-adjusted dose-response associations* of daily steps and all-cause mortality from studies that used wrist-worn (**A**) or waist-worn (**B**) accelerometers

A. From del Pozo Cruz et al. JAMA Inter Med 2022[2]. UK men and women aged 40-79 (mean: 61) years at accelerometry baseline (n=78,500). Wrist accelerometry. Log-relative hazard ratios

B. From Lee I-M et al. JAMA Intern Med 2019[13]. US women aged 62-101 (mean: 72) years at accelerometry baseline (n= 16,741). Waist accelerometry. Relative hazard ratios

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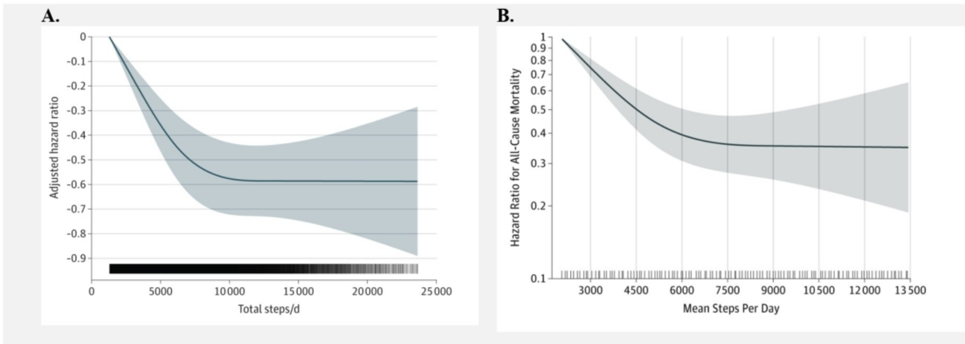
Figure 1



80x32mm (600 x 600 DPI)

Supplementary Image 1: Google trends of "10,000 steps" 2004-February 2023. Numbers on the Y-axis represent search interest relative to the highest point on the chart for the given region and time. A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular.

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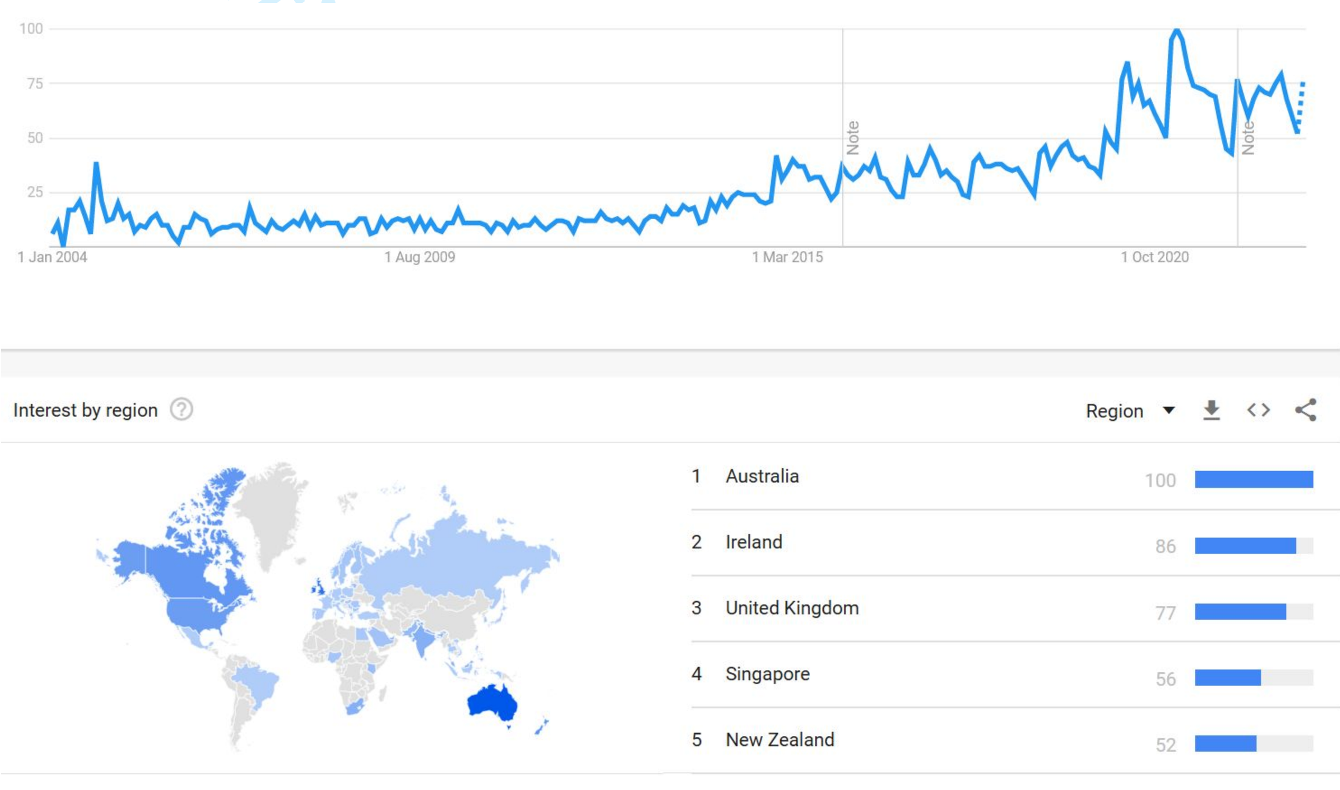

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1 Figure; 2 Supplemental items

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Opportunities

As ~~cohorts~~ cohort studies mature, it is likely that more stepping dose-response studies will be available to inform future guidelines. Consumer trends present another public health opportunity: it has never been easier to track steps and set goals through ubiquitous technology. For example, 93%[6] of people in the UK own smartphones capable of counting steps. Ownership of fitness trackers and smartwatches is also substantial (18% and 17%)[7], although there are clear socioeconomic inequalities in ownership[8] that may compromise population health gains through self-monitoring steps.

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Conclusions

As the only health behaviour that is passively tracked by nearly ubiquitous technology (smartphones), stepping has a privileged position. Stepping dose-response research has progressed in recent years, providing new insights to inform future physical activity guidelines. The challenges outlined above are *not* insurmountable, as previous guideline developers faced unquestionably — harder obstacles while developing the current time-based MVPA recommendations that largely relied onusing modestly valid self-reports of leisure-time physical activity. The coexistence of steps and time-based recommendations targets in any future guidelines requires caution to ensure that these the former provide are complementary rather than antagonistic to the latter targetsrecommendations.

Funding: ES is funded by the National Health and Medical Research Council (Australia) through an Investigator Grant (APP1194510)

Competing interests: None

Contributorship: ES and JMRG conceived the idea, ES drafted the material, all co-authors reviewed the manuscript critically and redrafted parts.

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